

Unit-1

MICROWAVE TRANSMISSION LINES-I

Introduction to microwaves

Microwaves – As the name implies, are very short waves .In general RF extends from dc upto Infrared region and these are forms of electromagnetic energy.

A glance look at the various frequency ranges makes it clear that UHF(Ultra high frequency) & SHF (super high frequencies) constitutes the Microwave frequency range with wave length (λ) extending from 1 to 100 cm

The basic principle of low frequency radio waves and microwaves are the same .Here the phenomena are readily explained in terms of current flow in a closed electric circuit. At low frequencies , we talk in terms of lumped circuit elements such as

C, L, R which can be easily identified and located in a circuit . On the other hand in Microwave circuitry , the inductance & capacitance are assumed to be distributed along a transmission line .

Microwaves are electromagnetic waves whose frequencies range from 1 GHz to 1000 GHz (1 GHz = 10^9).

Microwaves so called since they are defined in terms of their wave length, micro in the sense tinny ness in wave length , period of cycle (CW wave) , λ is very short.

Microwave is a signal that has a wave length of 1 foot or less $\lambda \leq 30.5$ cm . = 1 foot. F= 984MHz approximately 1 GHz

Microwaves are like rays of light than ordinary waves.

- Microwave Region and band Designation

Frequency	Band Designation
3Hz—30 Hz	Ultra low frequency(ULF)
30 to 300 Hz	Extra low frequency (ELF)
300 to 3000 Hz (3 KHz)	Voice frequency, base band / telephony
3 KHz to 30 KHz	VLF
30 to 300 KHz	LF
300 to 3000 KHz (3 MHz)	MF
3 MHz to 30 MHz	HF
30 to 300 MHz	VHF
300 to 3000 MHz (3GHz)	Ultra high frequency (UHF)
3 GHz to 30 GHz	SHF
30 to 300 GHz	EHF
300 to 3000 GHz(3 THz), (3 -30 THz,30 to3000 T)	Infra red frequencies

The Microwave spectrum starting from 300MHz is sub dived into various bands namely L, S, C, X, etc.

Band designation	Frequency range(GHz)
UHF	0.3 to 3.0
L	1.1 to 1.7
S	2.6 to 3.9
C	3.9 to 8.0
X	8.0 to 12.5
Ku	12.5 to 18.0
K	18.0 to 26
Ka	26 to 40
Q	33 to 50
U	40 to 60

Advantages of Microwave

There are some unique advantages of microwaves over low frequencies

1. Increased Bandwidth availability:

Here the available band width is 1 to 10^3 GHz compare with low frequency signal. 1000 sections crowded to transmit all TV , radio , music telegraphs. Current trend to use microwaves are fields like Telephone, space .Comm Telemetry Defense, Railways FM & digital modulation schmes

2. Improved directivity properties :

As frequency increases directivity increases ,so beam width decreases(for shorp beam of radiation
Eg.

$$\text{Parabola antenna } B = \frac{140}{D/\lambda} \quad \theta \text{ proportional to } \lambda/D$$

Where D is diameter of antenna ,
 λ is wave length in cm ,
B is beam width .

At 30 GHz ($\lambda= 1\text{cm}$) for 1° beame width D is 140 cm

At 300MHz ($\lambda= 100\text{cm}$) for 1° beame width D is 140 m

Power radiated also increases as f increases high gain is available

3. Fading effect and reliability
At microwaves fading is less on the signal transmission but at LF due to the transmission medium fading is more
4. Power requirements:
These are partly low for both transmission and reception at microwave frequencies

5. Transparency property :
From 300MHz to 10 GHz signals are capable of freely propagating through the ionized layers surrounding the earth as well as through the atmosphere like duplex .comm... exchange of information

APPLICATION AREAS OF MICROWAVES

- RADAR
- Surveillance (air traffic control)
- Navigation (direction finding)
- Meteorology 2-MEDICINE
- Treatment of Diseases
- Microwave Imaging 3-SURVEYING
LAND HEATING
- INDUSTRIAL QUALITY CONTROL
RADIO ASTRONOMY
- NAVIGATION VIA GLOBAL POSITIONING SYSTEMS
REMOTE SENSING
- POWER TRANSMISSION

As a result of common usage developed over the past half century, the microwave spectrum has been divided into bands, each with an identifying letter designation.

Letter Designation	Frequency Range	Wavelength Range
L- Band	1-2 <i>GHz</i>	30-15 <i>cm</i>
S- Band	2-4 <i>GHz</i>	15-7.5 <i>cm</i>
C- Band	4-8 <i>GHz</i>	7.5-3.75 <i>cm</i>
X- Band	8-12 <i>GHz</i>	3.75-2.5 <i>cm</i>
K_{μ} -Band	12-18 <i>GHz</i>	2.5-1.67 <i>cm</i>
K- Band	18-27 <i>GHz</i>	1.67-1.11 <i>cm</i>
K_a - Band	27-40 <i>GHz</i>	1.11-0.75 <i>cm</i>
U- Band	40-60 <i>GHz</i>	7.5-5 <i>mm</i>
V- Band	60-80 <i>GHz</i>	5-3.75 <i>mm</i>
W- Band	80-100 <i>GHz</i>	3.75-3 <i>mm</i>

ELECTROMAGNETIC SPECTRUM

